

Human Milk Fat Globule and its membrane

Claire Bourlieu^{1,4*}, Mathilde Cancalon^{1,4}, Nathalie Barouh³, M. Robert¹, Véronique Vié², Olivia Ménard⁴, Didier Dupont⁴, Amélie Deglaire⁴

¹UMR 1208 IATE, INRAE, Univ Montpellier, Institut Agro, Montpellier, France;

²IPR Institute of Physics, Rennes University 1, Rennes, France;

³UMR QUALISUD, CIRAD, Univ Montpellier, Univ Avignon, Univ Réunion, IRD;

⁴UMR 1253 STLO, INRAE, Agrocampus Ouest, Rennes, France;

claire.bourlieu-lacanal@inrae.fr

Human milk is recognized as the gold standard in neonatal nutrition. Human milk lipids present a very specific and complex structure at several levels of scale. At the molecular level, human milk lipids present a non random triacylglycerols regiodistribution with palmitic acid mainly located in *sn*-2 position, short to medium chain fatty acids located at *sn*-3 position, essential FA and long chain PUFA such as DHA to support the impressive infant cerebral and visual development during neonatal period. Human milk lipids also contains sterols, fat soluble vitamins and complex glycosylated lipids such as cerebrosides and gangliosides; at the macromolecular level, human milk lipids are organized under the form of “milk fat globules” (MFG) stabilized by a membrane rich in polar, complex, and bioactive lipids. These droplets have a mean diameter around 3–5 μm but present a large span in size distribution which covers the range of 0.1–15 μm . These droplets are based on an apolar core formed in the endoplasmic reticulum of the lactating cell, enveloped by an inner monolayer originating from this organite. An additional external bilayer surrounds this internal membrane as the droplets get pinched off the apical face of the lactating cell into the mammary lumen. The applications of biophysical tools (confocal laser scanning microscopy) enlightened the coexistence of phases in this tri-layered membrane. This phase heterogeneity results in more rigid domains that are resistant to digestion and enriched in sphingolipids and cholesterol, and in fluid phase very favourable for digestive lipases insertion. Recent findings have underlined the importance of the structure of human MFG on its digestibility and physiological fate: human MFG get aggregated but persist though gastric phase, present rapid gastric emptying and induce sharp postprandial lipemia peak. Conversely several elements of human MFG membrane (sphingolipids, glycosphingolipids, glycosylated proteins) resist upper digestion and contribute to gut maturation, immune and microbiota education. Through a non exhaustive narration we will thus take a journey through human MFG structure, see how this object favours fast energy transfer to neonate, evolves through lactation and digestion and presents a membrane resistant to digestion and possibly involved in programming.